RELIGION AND SCIENCE IN EARLY AMERICA:

A SURVEY OF THE EVOLVING RELATIONSHIP, 1607-1808

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II. INTRODUCTION

Many forces have shaped American culture. Two of them, which modern man seldom considers in juxtaposition, are science and religion. In modern thought science takes precedence over religion and the attempt is made to keep the two locked in separate rooms. In 1972, for example, the National Academy of Sciences declared that

> religion and science are...separate and mutually exclusive realms of human thought whose presentation in the same context leads to misunderstanding of both scientific theory and religious belief.[1]

But the intertwined histories of science and religion testify against the possibility of keeping them apart. Indeed, their fruitful interplay during the American colonial period helped to shape the tradition which still governs scientific enquiry in this country. The Europeans who settled the seventeenth century American colonies belonged to the "generation that first discovered the universe revealed by modern science."[2] They understood

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[1] Winton U. Solberg, "Science and Religion in Early America: Cotton Mather's *Christian Philosopher*." Church History, 56 (March 1987), 73.

[2] George H. Daniels, Science in American Society, (New York: Knopf-Borzoi, 1971), 69.

that universe in light of their religious faith, and believed that explanations of the natural world had important implications for that faith. They were not content, as was Galileo, to propose a separation of science and religion. There might indeed be a book of God's Word and a book of God's Works, but they both were God's, not man's. Any modification in the understanding of nature required a modification of the religious and philosophical synthesis by which both God's Word and His Works were explained. Although it was never wholly overturned, this prevailing world-view was to come under increasing scrutiny and challenge during the Seventeenth Century. Indeed, the groundwork for challenges to it had been laid over the previous two centuries.

If there is one central theme regarding science throughout the colonial and Revolutionary period of American history it is science as useful knowledge. From the earliest Puritan excursions into science until the close of Jefferson's presidency, to engage in scientific activity was to pursue useful knowledge. For the Puritans this utility was religious; they saw science as a means of explaining and describing the beauty and perfection of God's wondrous works. Early in the eighteenth century a second utility was interwoven with the earlier strand. That was social or humanitarian utility. Shortly thereafter a final thread of utility was added. That was economic and political utility. The latter two utilities differ

primarily in intent. The goal of the humanitarians was the use of science for the benefit of all mankind. Those who saw science as an aid to economics or politics sought improvement for national or personal gain. These three strands came to be intertwined during the eighteenth century, and still provoke debate over the proper role of science in society.

The early colonization of America took place in an age of changing and expanding knowledge. The explorations of the preceding two centuries had excited the imagination of Europe, revealing as they did a hither to un-imagined world. The writings and speculations of men such as Acosta, Hariot, Hakluyt, and Raleigh, had added to the store of knowledge regarding the Americas and had led to some fanciful speculations as to what could be found in these strange new lands. In Brooke Hindle's summary:

> America was settled in a wonderful age of expanding knowledge and hope. As Europeans became familiar with Asia, Africa, and America, a new picture of the physical world began to take shape, their imagination soared; and the limits of the possible receded before their dreams. Those who stayed at home were fed upon tales of strange new lands and unknown peoples - those who crossed the seas paid with their hardships for the sight of these strange scenes. Decades and centuries after the initial discoveries, the wonder still remained. New explorations and new knowledge seemed to expand the bounds of the unknown even faster than the limits of the known.[3]

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[3]Brooke Hindle, The Pursuit of Science in Revolutionary America (Chapel Hill: University of North Carolina Press, 1956), 11.

Added to this new knowledge about the world were new interpretations of the nature of the universe, and consequently of the relationship of man to God and of God to the universe. For in the seventeenth century ideas about the physical world and religious ideas were closely connected. Discussion of either was always connected to the other. The works of Galileo, Kepler, Bacon, Descartes, Gassendi, Boyle and Newton would all have an impact upon the American mind, but Boyle and Newton would have the most profound effect upon American thought.

Newton's influence was felt principally in the eighteenth century. Boyle, however, exerted an influence upon American patterns of scientific striving at least as early as the 1650's. The very Baconian process of cataloging and classifying the natural history of America which was undertaken by so many field agents in the seventeenth century followed Boyle's written guidelines for the gathering of information. Boyle had two driving passions: religion and science. His science was in all cases directed toward the service of his religion. The corpuscularian philosophy, which formed the basis of the new chemistry, was proposed as an antidote to the materialism of Descartes and Hobbes. This philosohpy was accepted fully by the leading colonial intellectuals in the late seventeenth century. What appealed most to the colonists, especially New Englanders, was Boyle's effort to turn the new discoveries of science

to the uses of religion. Boyle's argument from design played a significant role in colonial thought, and especially in the thought of Cotton Mather.

III. SCIENCE AND THE PURITANS

Any telling of the story of how the new knowledge and understanding of the natural world manifested itself in colonial life requires that the relationship between science and religion be examined. Such an examination must of necessity focus primarily on the New England colonies, because well into the Eighteenth Century New England was the center of colonial intellectual activity. There are numerous reasons for that. New England was intellectually pre-eminent because it was Puritan, and so committed to intellectual enterprise as a way of honoring God. It also had highly educated leaders who had been squeezed out of English universities, especially Cambridge. Settlement in New England took place in towns and villages. Closely clustered together, they not only provided for mutual defense, but greatly facilitated the communication of ideas. The concentration of population was to play an important role in the spread of new ideas about the natural world. Boston's commercial importance, moreover, gave it frequent communication with Europe which further aided the spread of ideas. The degree of Puritan influence in the intellectual life of colonial America is in part indicated by the fact that as late as 1689 the largest number of

churches in the American colonies were Congregational.[4]

Other regions were less vigorous intellectually. Philadelphia, which was to play a leading role in the American Enlightenment, did not exist until a half century after Harvard had opened its doors, while the southern colonies, notwithstanding the significant contributions made by some of their thinkers, lacked the urban centers necessary for the development of a vital intellectual life. No attempt is made here to claim that there was a lack of interest in science or learning in the South, but the conditions which made intellectual activity so much a part of the New England experience were to a large degree absent from the southern colonies.[5]

A further reason for focusing upon New England is the large body of scholarly work with suggests a link between

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[4]Lawrence A. Cremin, American Education: The Colonial Experience, (New York: Harper, 1970), p. 163. According to Cremin, out of 260 churches 116 were Congregational, 71 Anglican, 17 Dutch Reformed, 15 Baptist, 15 Presbyterian, 12 French Reformed, 9 Roman Catholic, and 5 Lutheran. No figures are cited for Quaker, Mennonite, or other small sects.

[5]An extended treatment of southern science and attitudes toward education is contained in Richard Beale Davis, Intellectual Life in the Colonial South, 1583-1763 (Knoxville: U of Tennessee Press, 1978. Volumes I and II contain the relevant material; Ronald L. and Janet S. Numbers "Science in the Old South: A Reappraisal," Journal of Southern History 39:2 (May, 1982), 163-184, cover the period 1800-1860. They conclude that the lack of urban centers was a hinderance to the development of science in the south. There was no lack of interest in science, but the lack of intellectual centers and the distance between major urban centers was an impediment.

religious dissent in England and the rise of modern science.[6] A major argument of this paper is that America experienced similar developments, especially among the Puritans. Events in America did not exactly follow the English pattern because the needs of the colonists were different and there was a delay in the transmission of the new science. What is clear, however, is that there was some of the same emphasis on social utility and on the millenarian aspects of the early English reformers. Always present in English protestant thought, millenarianism was emphasized even more than commonly by the Puritan reformers. Using Bacon as a "guide to the scientific spirit ... they emphasized the millenarian and reformist aspects of his thought."[7] Within the emerging scientific thought were ideas which emphasized the ability of science to improve the lot of the working classes and, at the same time, aimed to reform man and society in preparation for the millennium. These ideas were shared by New Englanders, but their emphasis was less on social control and stability than on improvement of the condition of man and the understanding of God's works. New Englanders, like their English exemplars, also rejected the authoritarian

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[6] See Margaret C. Jacob, The Cultural Meaning of the Scientific Revolution, (New York: Knopf-Borzoi, 1988), 73-104.

[7] Jacob, Cultural Meaning, 74.

philosophy of Scholasticism, but without the radical sectarianism which developed in England in the 1640's. Radicals of the period sought change in all areas based on new understandings of their world.

The rise of modern science caused changes in the understanding of nature. That, in turn, led to some wild speculation about man's relationship to both nature and to God. It also led to speculation that there was no need for organized religion, or ministers, and even to the conclusion that traditional civil authority could be eliminated. These kinds of problems were increasingly responded to by the writings of ministers in the last decades of the seventeenth century.

> The New England literature is part of a wider movement, inspired no doubt, as among the Cambridge Platonists and in the works of Joseph Glanvill, by apprehensions lest the all-conquering science result in a theory of blind mechanism or endorse the blasphemies of Thomas Hobbes.[8]

Early in the eighteenth century there was a repudiation of the idea of predestination among some New Englanders and an increased emphasis upon free will and striving. Also apparent was a concern for order, design, and harmony in the universe. Both of those tendencies had their origins in the liberal or latitudinarian Anglican theology which

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[8]Perry Miller, The New England Mind: The Seventeenth Century, [Vol. 1], (Cambridge: Harvard University Press, 1954), 228-229.

developed in England in the late 1650's, and which was wedded to the Puritan belief in the material benefits of science.

> This scientifically grounded latitudinarianism received its classic formulations in the works of Robert Boyle published after 1660 and in Thomas Sprat's *History of the Royal Society* (1667) masterminded by John Wilkins.[9]

Finally, Daniels suggests that New England offers a unique opportunity for observing ideas in action. He writes that

> In a word, with the New England Puritans, we have a unique, laboratory-type situation. It was a small, homogeneous society -- numbering no more than one hundred thousand by 1700 -- transplanted to a New World, accessible only with difficulty, and carrying with it the best of current learning. We are able to observe in New England, as nowhere else, the actual process of intellectual change.[10]

New England makes a remarkably convenient model of intellectual history, in part because its intellectual leadership was in the hands of a very small number of men, who were all university graduates, and mostly ministers. Citing lists compiled by Franklin Bowditch Dexter and Samuel Eliot Morison, Cremin estimates that New England had "at least 130 university men among those who immigrated before 1646."[11] It was those men who set the standards for their communities. From their pulpits they expounded upon

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[9] Jacob, Cultural Meaning, 84.

[10] Daniels, Science, 71.

[11] Cremin, American Education, 207.

the meaning of the natural and supernatural. They oversaw colonial education, and for nearly a century controlled all facets of New England intellectual life. It was to this educated elite that the common people looked for explanations of the ordinary and extraordinary occurrences of daily life. The graduates' intellectual leadership imparted both continuity and consistency to New England life. They also showed their communities how to modify the prevailing religious understanding of the world and of how God works in the world in light of new scientific knowledge.

The congregational nature of church governance served to restrict ministers in some respects. Theological speculation was limited by what the community would tolerate. Toleration operated within narrowly prescribed bounds and ministers were evaluated for the correctness of their views as well as their erudition. To insure theological consistency a church synod (1637) and the General Court of Massachusetts (1646) defined the limits of theological speculation.[12] Not surprisingly, then, New England ministers produced little controversial theology.

But they were expected to demonstrate their learning in their sermons. The sermon was the central element of

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[12]Samuel Eliot Morison, The Intellectual Life of Colonial New England, (New York University Press, 1956), 169.

Puritan religious ceremony. Sermons not only interpreted scripture, but also provided explanation of the ordinary and extraordinary occurrences of daily life. The minister was expected to speak at length (an hour was considered the minimum), and to draw out the meaning of the text selected as the topic. He was, first and foremost, a teacher. "Hence the teaching function, implicit in every Christian ministry, was explicit and almost exclusive in the puritan ministry."[13] Because of that, the Puritan minister was more than just a religious leader. He exercised intellectual leadership in all areas of community life: social, political, as well as religious.

A characteristic of Puritan theology which played a very important role in the development of science is the rational and empirical character of Puritan thought. Puritanism had two main currents of thought, one leaning toward the mystical and emotional, the other, informed by Ramist logic, toward a more rational understanding of the universe. Reason played a most important role in Puritan thought, and many Puritans believed that the universe was rational and amenable to man's understanding of it through the use of his reasoning powers. This belief was even extended to the understanding of the Bible. "Even the most orthodox

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[13] Samuel Eliot Morison, The Founding of Harvard College, (Cambridge: Harvard University Press, 1963), 160

Puritans believed that the truth of Scripture was to be upheld by 'right reason'."[14]

Puritans took care not to extend the rule of reason too far. Knowledge was no guarantee of salvation, and for every quotation from a Puritan minister which extols reason there can be found examples by the same divine which indicate the limits of reason. For as Perry Miller points out so beautifully:

> there was for the Puritan a hierarchy of comprehension, what Preston called a "three-fold kinde of Truth": on the first plane there was natural truth within the heart of men; on the second there was the common knowledge that natural men could acquire from theologians and books; on the third was spiritual knowledge. All men had the first, all might gain the second, only grace could give the third; yet on that level alone was redemption to be secured.[15]

Because of their religion's intellectual emphasis, Puritans, to a much greater degree than other colonists, needed a complete educational system. They needed, as Morison says, "a learned clergy, and a lettered people."[16] New England alone, of all the colonies, was able to establish a complete educational system, making provision for primary schools, grammar schools and a college within the first generation of settlement.

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[14] Merle Curti, The Growth of American Thought (New York: Harper, 1964), 107-108.

[15] Miller, The New England Mind: Vol I, 30.

[16] Morison, The Founding of Harvard, 45.

One of the goals of their college was to train a learned clergy. More broadly, however, it meant to advance learning as the colonial leaders had known it at Cambridge. In the early 1600's Cambridge, like the other European universities, emphasized Aristotelian philosophy and logic, the astronomy of Ptolemy, and theological training. Mathematics and science were not generally included within the university curriculum. Arithmetic was simple ciphering, geometry was considered fit only for mechanics, and medicine was not yet a part of the university curriculum. The medieval arts and sciences (seven arts, three philosophies) was the basis of Harvard's curriculum just as it was of the European universities. Though no university curriculum was narrowly vocational, Cambridge expected that most of its graduates would become ministers. Harvard, on the other hand, prepared young men for any and all positions of responsibility in their communities. Certainly ministerial training was important, but the needs of the colony included an educated body of men to become the teachers, physicians, and magistrates of the future.

Despite Harvard's emulation of Cambridge, the intellectual life of Europe was not transferred complete and unchanged to the shores of America. The physical environment left little time for speculative thought. There were no coffee houses, books were hard to come by, and it would be several years before a printing press would be set up

in New England. The colonies and Europe faced different problems. Surviving in the new land had an urgency which took precedence over intellectual endeavors.

The greatest intellectual difference between the colonies was that ideas, which sparked such controversy and discussion in Europe during their development and modification, would reach America in completed form, as accepted truth, if they reached these shores at all. Those new ideas, which would so change man's understanding of both the natural and the supernatural, arrived without all of the usual controversy and modification to which new ideas are ordinarily subjected.[17]

A frequently cited example of that is the series of almanacs prepared at Cambridge between 1656 and 1661 by T. S. Philomathemat.[18] The first issue discusses Ptolemaic Astronomy. The issue of 1660 mentions in passing that the Ptolemaic observations might not be accurate. The following yearly edition wholehartedly endorses the new astronomy of Copernicus, Galileo, and Kepler with no indication of

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[17] Curti, The Growth of American Thought, 24-25, suggests these ideas in general form. They are discussed in more concrete terms in Daniels, Science, Ch. 4, "The Transit of Ideas".

[18] Marion Barber Stowell, Early American Almanacs: The Colonial Weekday Bible, (New York: Burt: Franklin, 1977), 41, indicates that the T. S. probably stood for Thomas Shepard and that Philomathemat, or a derivation thereof, was a common pen name used by authors of the early almanacs.

what led to such a change in belief. Completely missing from the colonial literature was the debate which surrounded the new astronomy.[19]

Despite the difficulties which distance from Europe presented, the Puritans of New England were remarkably well-informed regarding scientific developments in Europe. They were curious, receptive to new knowledge, and willing to incorporate the new science into their theology.[20] Beginning with the second generation of settlers, the Puritan ministers, clustered about Boston and Cambridge, formed the largest body of Americans with scientific interests until the middle of the eighteenth century. Far from impeding their thought, Puritan theology made them distinctively receptive to new scientific ideas.

To Puritans of the seventeenth century, "the universe was to be studied and expounded because it was the providence of God in operation."[21] How the universe worked or which system explained it best was always less important than the "task of explaining how God always worked in nature through a settled order and yet secured intelligible

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[19] Daniels, Science, 75.

[20] Leading exemplars of this shift in thought include Thomas and William Brattle, John Wise, and John Leverett. Even Increase and Cotton Mather incorporated new scientific understanding into their sermons and writings.

[21] Miller, The New England Mind, Vol. 1, 216.

ends...."[22] God's covenant with man restricted Him to observing the laws of nature. Yet at the same time His omnipotence required that whatever He ordained should come to pass. It mattered little to Puritans which system explained how that happened.

> The thought that there could be a conflict between their understanding of nature, God's noblest work and a living testimony to His constant operations, and their concept of the majesty of God would have been inconceivable to seventeenth century American Puritans, and it remained so for as long a Puritanism endured.[23]

The number of men engaged in scientific endeavors was quite small and remained so throughout the colonial period. There was never a leisure class which could devote full time to such matters; the Puritan clergy, whose work was supposed to center on study, were as close as America came to that. The colleges supported no scientific professoriate. Indeed, the institutionalization of the new knowledge within the curricula of the colonial colleges was a slow process which was not fully accomplished until the last half of the eighteenth century. In any case, colleges were too few and scattered to contribute much to any sort of intellectual culture. Harvard remained the sole colonial institution of higher learning until joined by the College of William and Mary in 1693. Yale was founded in 1701

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[22] Miller, The New England Mind, Vol. I, 216-217.

[23] Daniels, Science, 89.

followed by the College of New Jersey (Princeton, 1741), King's College (Columbia, 1754), the College of Philadelphia (University of Pennsylvania, 1755) the College of Rhode Island (Brown, 1764), Queen's College (Rutgers, 1766), and Dartmouth (1769).[24]

The principle means of communicating the new science was through sermons, tracts, and almanacs. Alamancs played an important role in the popularization of the new science. At a time when access to books was extrememly limited, any literate American could obtain an almanac for a few pennies a year and discover for himself the secrets of the universe as revealed by the new science. The seventeenth century almanacs, generally referred to as Philomath or Cambridge almanacs, "included explanatory notes for the calendar, a discussion of eclipses, the calendar pages, verse, and approximately two pages of astronomical, religious, or historical essays."[25] Over time the character of the almanacs changed so that by the late seventeenth century the emphasis was no longer on educating the reader in the new science, but upon useful knowledge of all kinds. The farmers' almanacs of the eighteenth century included astrology, humor, satire, advice to farmers, but little

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[24]Raymond P. Sterns, Science in the British Colonies of North America, (Urbana: University of Illinois Press, 1970), 504-505.

[25]Stowell, Early American Almanacs, 61.

information on the actual practice of farming.[26] Almanacs outnumbered all other publications printed throughout this period. They were instrumental in spreading the new science among the populace and "may well have influenced the growth of deism, even rationalism, in America."[27]

Beginning in the 1650's almanacs provided a forum for the dissemination of scientific knowledge. Astronomy was a particular early favorite of the almanac makers. Expanding their almanacs by a page or two, they offered the latest available information on the works of Copernicus, Galileo, Gassendi, and Kepler.

The works of Gassendi particularly interested Americans. His astronomy test was in use at Harvard as early as 1675 and made its appearance in several almanacs as early as 1659. Harvard students are known to have owned copies and his works were used as a text in America for at least fifty years. There are a number of possible reasons for this interest in Gassendi. Harvard generally followed the pattern set by Cambridge and the astronomy of Gassendi was used there and in the English dissenting academies. The interest of the Puritan clergy in astronomy is another probable reason as is the fact that Gassendi had compiled

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[26] Stowell, Early American Almanacs, 61-63.

[27] Stowell, Early American Almanacs, xv.

a very readable text which provided extensive discussion of the works of Copernicus, Galileo, and Kepler.[27]

In 1659, the New England almanac, "compiled by Harvard tutors and graduate students," included a description of the Copernican system. Written by Zechariah Brigden, it presented that system as "'the true and genuine Systeme of the world'".[28] Paralleling the arguments advanced by Galileo, Brigden

> must have anticipated that these astronomical theories might conflict with some readers' religious beliefs. He cautiously proposed that reason be the basis of judgement for his sophisticated reader, while admitting the utility of a literal view of scriptures for the uneducated.[29]

Both Charles Chauncey, president of Harvard, and John Winthrop, Jr., governor of Connecticut, sent copies of the almanac to John Davenport, the minister at New Haven. Davenport, one of the first generation of settlers, had "Founded the town and colony of New Haven" and was "the principal pillar of the state and pastor of the church."[30]

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[27]Daniels, Science, 72 contains a short reference to Gassendi. See also Mel Gorman, *"Gassendi in America"*, Early American Science, Ed., Brooke Hindle, (New York: Science History, 1976), 133-143. He presents an interesting discussion of the place of Gassendi in the thought, and in the libraries, of early America.

[28]Morrison, Intellectual Life, 247.

[29]Stowell, Early American Almanacs, 44

[30]Morison, Founding of Harvard College, 374.

Davenport was very conservative and was ever ready to uphold orthodoxy or expose heresy. Yet instead of having Brigden fired, kept from preaching, or banished for heresy, Davenport merely stated in his reply to Winthrop that he personally remained unconvinced, and would continue to "'rest in what I have learned, til more cogent arguments be produced'".[31] Such a reaction was typical. The science of the times was generally accepted, or at least tolerantly received, by the Puritan leadership, and was increasingly incorporated into their theology.[32]

Astronomy was a major interest of these early American men of science. There are several reasons for that. First, they believed that God used heavenly signs as indications of his displeasure. That was a recurrent theme in Puritan sermons and tracts. A second consideration is that Aristotelian texts had always begun with heavenly bodies. A third factor is that the new astronomy of Copernicus, Galileo, and Kepler posed theological and philosophical problems which had to be addressed. For Puritans in New England, reason demanded that those ideas be accommodated within the context of Puritan theology. Finally the interest in astronomy may have been due simply to the large number of comets which occurred in the seventeenth century.

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[31] Stowell, Early American Almanacs, 44.

[32] Daniels, Science, 90-91.

A special interest in comets is understandable in Puritan New England for both scientific and theological reasons. Puritan theology had always granted a place to signs and special providences. While the early literature shows less emphasis on special providences than would appear late in the seventeenth century, extraordinary events were recorded throughout Puritan New England's short history. Signs "were warnings of punishment to come" and "might generate much public anxiety".[33]

> Celestial phenomena of various kinds made an obvious case in point: comets, eclipses, meteors, aurora, even rainbows. Here it seemed were messages flashed directly from the heavens "to awaken the secure world."[34]

Increased awareness of, and exposure to, the new astronomy had thoroughly prepared New Englanders for the comet of 1664-1665.

Two essays cited by Morison are interesting for the similarity of their understanding of comets despite the difference of a generation between the two authors. They are also striking in the modernity which they demonstrate. Samuel Danforth, a 1643 Harvard graduate who served the Roxbury church, prepared "a tract of one hundred and twenty-two pages called *An Astronomic Description of the late*

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[33]John P. Demos, Entertaining Satan: Witchcraft and the Culture of Early New England, (New York: Oxford University Press, 1982), 377.

[34]Demos, Entertaining Satan, 377.

Comet or Blazing Star, with a brief Theological Application thereof.[35] Alexander Nowell, a recent Harvard graduate, contributed an essay on astronomy to the Almanac of 1665. Entitled *The Suns Perogative Vindicated,* it cited European astronomers and closed with some ideas on comets. Despite the difference in the generations of the respective authors, they shared a remarkable similarity of view. Both agreed that comets are natural phenomena, subject to the laws of mathematics, and have the same material as stars. Yet both men "insisted that comets are divine portents of impending disaster".[36] The combination of a rather modern scientific outlook with supernaturalism may seem absurd to the modern reader. For Puritans it presented no such difficulty. God worked through the natural order, but being God, He had the power to disrupt the natural order to send signs of His displeasure to an errant people. The sermons, tracts, and other writings of Puritan divines were filled with like examples until well into the eighteenth century. Such beliefs linger in modern society, for as Morison points out we do something very similar when we pray for rain and expect God to intervene in nature to answer our prayers.[37]

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[35]Morison, Intellectual Life, 248.

[36]Morison, Intellectual Life, 249.

[37]A more eloquent expression of this is found in Sterns, Science in the British Colonies, 161.

The comet of 1680 is especially interesting, both for the excitement it generated among scientists around the world and for the observations of an American, Thomas Brattle. Using the Harvard telescope, he made careful observations based on the position of fixed stars. His results were printed in the Harvard almanac. He also sent "them to Flamsteed, the Royal Astronomer at Greenwich, who in turn sent them to his friend, Newton".[38] Those observations "when they reached Newton, helped him to prove that the paths of comets are determined by the field of gravity".[39] It is in this manner that a New Englander played a part, however small, in Newton's monumental work, the *Principia*.

> Newton, in his *Philosopiae Naturalis Principia Mathematica* (London, 1687), after citing several "rude" observations of this comet, said that "those made by Montenari, Hooke, Ango, and the observer in New England, taking the position of the fixed stars, are better".[40]

Brattle continued to make astronomical observations until his death in 1713. He used the three and one-half foot telescope, which had been donated to Harvard by John Winthrop, Jr., until it was replaced with a larger, better

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[38] Morison, Intellectual Life, 252.

[39] Perry Miller, The New England Mind: From Colony to Province, (Cambridge: Harvard University Press, 1953), 438.

[40] Sterns, Science in the British Colonies, 153; but see also Morison, Intellectual Life, 253.

instrument. With Henry Newman he made astronomical observations, using a brass quadrant, of the 1694 eclipse. He sent them, along with other observations, to the Royal Society. Upon his death, his brother William was elected to membership of the Royal Society in recognition of Thomas' work. William declined the election because he considered himself unfit for membership.

Increase Mather used the telescope to observe Halley's Comet in 1682 after which he published a work entitled *'Kometographia, or a Discourse Concerning Comets'*. It was issued at Boston in 1683 and borrowed heavily from a work published by Helvelius at Danzig in 1668 entitled *'Cometgraphia'*. His interest in comets had been excited by the great comet of 1680, after which he

> undertook a course of reading in the latest European astronomical studies, from which he emerged (or which perhaps confirmed him in being) a champion of observation and mathematical reasoning and an opponent of the abstract logic of Aristotle.... Although his *Kometographia* (1683) persists in treating comets as portents of coming events, it also recognizes that comets move like planets, cites the work of Johann Kepler, and dabbles in astronomical mathematics.[41]

In 1680 he preached two sermons relating to the comet of the same year. Convinced that comets were natural events and familiar with the works of European astronomers, he nevertheless believed that history showed a relationship

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[41] Kenneth Silverman, The Life and Times of Cotton Mather, (New York: Harper & Row, 1984), 40.

between the appearance of comets and human misfortune. This half-way view regarding natural phenomena was by no means uncommon in that age. The acceptance of the belief that comets, earthquakes, and other wondrous occurrences had natural causes did not eliminate the hand of God in their occurrence. Rather, it was an affirmation that God could and did use natural events, the more readily understood by man, to signify His displeasure with the actions of mankind. Puritan divines used their new understanding of nature to demonstrate the majesty of the Creator.

Increase Mather's receptivity to new explanations of natural phenomena provides a stark contrast to the treatment Galileo received fifty years earlier. As Morison points out, "his (Mather's) point of view was worlds apart from that of the ecclesiastics who had condemned Galileo in 1633, for an hypothesis that was contrary to Holy Writ".[42]

Another, perhaps clearer, picture of how far Increase Mather had moved in the direction of the new learning is presented by Daniels. Tracing Mather's interest in science to at least 1664, Daniels illustrated his "receptivity to science" by the following example:

> In 1669, commenting on the passage in Mathew 25:29, "and the moon shall not give her light and the stars shall fall from heaven" Mather comments: "Yea, some imagine that the Stars shall really fall from the

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[42]Morison, Intellectual Life, 254.

> heaven to the earth; but this cannot be, for how should the stars fall upon the earth, when one Star is greater than the earth."
> Clearly, since there was an apparent conflict, it was the understanding of the biblical statement that must be adjusted to conform to the physical universe, not the reverse.[43]

Celestial phenomena were not the only scientific interests of Puritans. John Winthrop, Jr., governor of Connecticut, and the first American elected to the Royal Society, was a physician, metallurgist, assayer of ores, chemist, alchemist, natural historian and astronomer. No area of scientific endeavor escaped his attention, although his primary interest was chemistry. His library was the most complete scientific library in the colonies. He corresponded widely with some of the most eminent men of the age including Boyle, Digby, Wren, Hartlib, Glauber, Kepler, and Von Helmont. He regularly corresponded with the Royal Society and transmitted papers and specimens often, though much of the material that he sent to England was lost or delayed.

Winthrop was the first American correspondent of the Royal Society. Primarily a gatherer of facts, and a promoter of the ideas of the Society, he had little time, and fewer resources, to devote to theoretical speculations. There were few men in the colonies with whom he could share

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[43] Daniels, Science, 91-92.

his chemical interests, though he did correspond regularly with Jonathan Brewster and Gershom Bulkeley, fellow residents of Connecticut, who also conducted chemical experiments.

Winthrop, because of his wide-ranging correspondence and travels, and his promotion of the interests of the Royal Society, is credited by many with sowing the seed from which grew the first community of scientists in America. His interest in astronomy led him to donate a telescope to Harvard. It was this device that Brattle used for his observations of the comet of 1680. The same telescope served Increase Mather and his son, Nathaniel.

Consistent as was Puritan interest in science throughout New England history, it increased markedly at the end of the seventeenth century. That was partly because of the Royal Society's encouragement and partly because of local effects. In New England Increase Mather gathered a group of men interested in the new mechanical philosophy together into the Boston Philosophical Society. Founded in 1683, and continuing for only a decade, it was not only the first American scientific organization modelled after the Royal Society, but the first such imitator in the world. One of its goals was to compile a natural history of New England in accordance with the plan of Robert Boyle.

That plan never came to fruition, but did result in the establishment of a small group of like-minded individuals

who shared their ideas about the new philosophy. Cotton and Nathaniel Mather along with Thomas and William Brattle were almost certainly members. Others who may have attended were "Dr. William Avery of Boston and Dr. Jonathon Avery of Dedham", his son. Additionally, Hezekiah Usher, Waitsill Winthrop, Joseph Dudley, and Edmund Randolph were likely attendees. Most probably Samuel Sewall was a member "although his diary is curiously silent on the subject".[44] Sterns makes no mention of Samuel Lee, although he was a likely candidate for society membership. Charles Morton, who also arrived from England in 1686, is listed as a probable member of the group.

The Boston Philosophical Society did not survive the colonial problems of the last decades of the seventeenth century and was never officially re-instituted. What did survive was the spirit, and the idea, of a community of men gathering together to share their views on the new experimental philosophy. From this initial beginning other scientific communities were to form and by mid-century there existed an interlocking network of such communities throughout the colonies.[45]

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[44]Raymond P. Stearns, Science in the British Colonies, 156-158.

[45]Stearns, Science in the British Colonies, 398-399. Also footnote 2 is instructive as regards the possible reason for the spread of science to other colonial centers.

Boston, which still maintained its intellectual preeminence, was the site of one such community in the early eighteenth century. That was an outgrowth of the Boston Philosophical Society, though only Cotton Mather from that earlier group was an active member. Its twenty or so members, "seven of whom were elected Fellows of the Royal Society,"[46] shared ideas despite some personal animosities. No longer content to be mere field agents for British science, they began to contribute ideas, theories, and research to the growing body of scientific knowledge.

The most prominent member of the group was Cotton Mather who is described by Raymond P. Sterns as

> the first native-born American to advance beyond the status of a mere field agent for European scientists in the New World and to demonstrate a genuine *philosophical* approach to science, with scientific *ideas* and *hypotheses* of his own.[47]

Cotton Mather is also the most paradoxical of all the early American men of science. The first American to completely accept Newtonian science, he is remembered by many primarily for his role in the Salem witchcraft trials.

Mather was an extremely complex and contradictory individual. His role in the witchcraft epidemic which swept Massachusetts in the late 1600's provides a perfect

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[46]Sterns, Science in the British Colonies, 485.

[47]Sterns, Science in the British Colonies, 426.

example of this complexity. His reputation as a man and as a minister was badly tarnished by his self-seeking and self-justification in this affair. On the other hand, his scientific activities were fully in keeping with the latest in Enlightenment thought.

This was a transitional period during which new scientific ideas were co-mingled with old beliefs in magic and the spirit world. Such beliefs held an urgency for men of that age because of the debate then raging over the role of spirit in the universe. Some sought to banish spirit from the world. Philosophically, to men such as Mather, and the Englishmen he was most familiar with, if there were no spirit there could be no God. They believed that the existence of devils proved this existence of God. "As Mather himself told his congregation, since there are Witches and Devils, we may conclude that there are also Immortal Souls'."[48]

His scientific interest in diabolical possession took several forms. First, he sought to understand how demons work and the limits of their powers. He also sought to determine if it was possible to communicate with demons. Finally he believed that the mind could cause illnesses of the body and he attempted to treat problems of possession

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[48]Silverman, The Life of Cotton Mather, 92.

as if they were illnesses. While his methods were crude there can be little doubt that he attempted to perform his experiments in a manner that was fully consistent with the scientific rationalism of the early Enlightenment.[49]

Mather, with all his complexities and contradictions, richly illustrates the transition from seventeenth century thought to the Enlightenment. As Daniels writes:

> Mather's complex character is indicated by the fact that he has been variously described by historians as a "witch-burner", a "Puritan priest," and a "deist." His election to the Royal Society in 1713 was a testimony to his many contributions to natural history, including observations on "giant bones," which he presumed to be antediluvian remains of the giants mentioned in the Bible (an interpretation that had been current since the time of Acosta), weather observations and a pioneering article on hybridization in corn. His championship, against vigorous opposition, of small pox inoculation during a Boston epidemic and his manuscript *Angel of Bethesda* - a medical work that included acceptance of a rudimentary germ theory of disease - has earned him the title, from two historians, of "the first significant figure in American medicine".[50]

Cotton Mather first showed his interest in the new science while he was a student at Harvard. Mather had determined to become a physician because he had a speech

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[49] David Levin, Cotton Mather, 195-220 offers an clear picture of Cotton Mather's role in the Salem trials; Demos, Entertaining Satan, 98-99, offers an interesting view of minister as clinician: interviewing, studying and presenting conclusions on diabolical possession; see also Silverman, 92-93, for philosophical reasons supporting a belief in witches and for an idea of the relationship between religion, science and the world of spirits.

[50] Daniels, Science, 77.

impediment which he believed would disqualify him from becoming a minister. His family also played a role in his developing interest in science. Both his father and grandfather, John Cotton, had been interested in natural philosophy. John Cotton "had considered it a divinely imposed duty to 'study the nature and course, and use of all God's works'".[51] As early as the 1680's one finds strong evidence of his belief in design in the universe. A recent biographer notes:

> ...his observations through telescope and microscope were acts of devotion themselves, giving new grounds for praising the Almighty by enhancing his sense of the perfect design of things. "Every Wheel in this huge clock," he preached in his twentieth year, "moves just according to the Rule which the All-wise Artist gave it at the first".[52]

Daniels adds that he was permanently affected by his exposure to modern science at Harvard, but argues that the likely source of Mather's belief in design was the arrival at Boston of the Reverend Samuel Lee in 1686.[53]

Lee, a famous dissenting minister, was warmly received by the intellectual elite of Boston. He brought with him an extensive scientific library. More importantly, he brought a close personal knowledge of the work of his friend Robert Boyle. Because Boyle's ideas and those of

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[51] Silverman, 40.

[52] Silverman, The Life of Cotton Mather, 42.

[53] Daniels, Science, 76-79.

other new philosophers began appearing in the works of Cotton Mather so shortly after Lee's arrival, Daniels concludes, while allowing for other possibilities, that the source was probably Lee.

Wherever he may have gotten the idea, Cotton Mather was the first American to fully express the Enlightenment's characteristic argument from design. That occurred in his 1690 sermon *The Wonderful Works of God Commemorated*. From this point on his work shows both a growing acceptance of the ideas of natural religion and the argument from design. This culminates in 1721 with his *Christian Philosopher*, which is "the first general Newtonian approach to physical science published by an American".[54]

Both natural religion and the argument from design are basic to the enlightened view of the eighteenth century. As Solberg makes clear, neither idea is original with Cotton Mather. The idea that evidence of design in the universe implies the existence of a designer was first proposed by Plato. Plato was also the leading spokesman for the concept that "human nature can know the existence and attributes of God from the evidence of nature." Revived by seventeenth century English scientists and philosophers, and especially Robert Boyle, the concept of natural

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[54]Daniels, Science, 82.

religion was fully developed by John Ray in 1691.[55]

In his analysis of *The Christian Philosopher*, Solberg cites the fact that the work is both highly derivative and, more importantly, transitional in nature. Mather is not quite the enlightened philosopher. Most other historians of science agree that the work is transitional and that it was written as scientific support for Mather's religious beliefs. Sterns, in citing two earlier historians of science, writes that

> His two great works, the unpublished *Biblia Americana*, and the published, *Christian Philosopher*, were, as Beall and Shryock have said, two sides of the same coin. The former an effort to reconcile biblical revelation with the new science, the latter a survey of the new science from the perspective of the Christian religion.[56]

Neither the transitional nature of the work, nor the fact that it was not fully original, diminishes its importance. It is a modern work which introduces, in terms which men a generation or two later would fully accept, the concept of natural theology, and the argument from design, to educated inhabitants of British America.

Mather's intent in writing *The Christian Philosopher* was to gather together the most important scientific ideas of the age in order "to show the spirit in which he had

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[55]Solberg, Christian Philosopher, 74.

[56]Sterns, Science in the British Colonies, 425-426.

pursued his own" studies of nature. He sought to leave a guide for future generations on "how a Christian might come to terms with the new science himself".[57] With those intentions in mind, it is not at all surprising that he relied on the scientific writings of others or that he used science to buttress Christian faith. He did exactly what we should expect of an eighteenth century Christian scientist. "Like most vitruosi in the Royal Society, Mather believed that the investigation of nature could lead only to the good of man and the greater glory of God."[58]

Mather drew heavily on the works of John Ray and William Derham. Like them, he found God's beneficent purpose in the operation of the universe. Inadvertently these men had come very close to eliminating the need for religion, for obscured by the picture of a benevolent God who had so ordered the universe that whatever was natural was also good was the unrecognized fact that once God had set this clock-like universe ticking He was no longer required. Also called into question by such a mechanical universe were supernatural grace, providences, portents, miracles, and the very "standards of proof and debate" upon which Christianity had so long relied.

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[57] Silverman, The Life of Cotton Mather, 249.

[58] Silverman, The Life of Cotton Mather, 249.

> In trying to prove God's existence from natural phenomena, and in using new standards of proof and debate, it [the new science] quietly relegated essential Christian ideas to the background, especially losing sight of the Son.[59]

Mather, unlike men of later generations, could not accept the idea of a wholly mechanistic universe partly because of his experiences with witchcraft and partly because of his belief that because so much remained unknown about the universe there remained large areas in which spirit could operate. Despite those reservations, he was one of the strongest supporters of Newtonian physics, and the ideas expressed in *The Christian Philosopher* are among the most important in the early development of the Enlightenment in America.

Other members of the Boston scientific community in the early eighteenth century were Zabdiel Boylston, a pioneer in smallpox inoculation and in the use of medical statistics, and Thomas Robie, who shared a small role in smallpox inoculation and was a Harvard tutor in mathematics, astronomy and natural philosophy. A physician, Robie was interested in astronomy and meteorology, and believed in the natural explanation of observed phenomena. He was also the teacher of Isaac Greenwood, the first Hollis Professor

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[59] Silverman, The Life of Cotton Mather, 250.

of Mathematics and Natural Philosophy at Harvard.[60]

Greenwood was instrumental in securing the endowment from Hollis for the chair which he held at Harvard. He is credited with establishing an excellent program of instruction and greatly adding to the philosophical apparatus of Harvard. His greatest achievements were in teaching his successor, John Winthrop, IV, and in conducting the first public lectures and demonstrations of science, which broadened scientific interest and support.[61] Both the charge of that chair in natural philosophy and Greenwood's public demonstrations are characteristic of Enlightenment activity.

Other members of the group included Paul Dudley whose interest in natural history resulted in several contributions of lasting scientific significance. They included explanation of the role of wind in the cross pollination of Indian corn, the source of ambergris in whales, and the distinction between the hemlock and the spruce. Benjamin Colman was a scientific amateur who supported Cotton Mather

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[60] Fredeick G. Kilgour, *Thomas Robie (1689-1729), Colonial Scientist and Physician*, Early American Science, Ed., Brooke Hindle, (New York: Science History, 1976), 67-84.

[61] Miller, The New England Mind, Vol. II, 444; Stearns, Science in the British Colonies, 446-455 provides a capsule portrait of Greenwood; Merle Curti & Roderick Nash, Philanthropy in the Shaping of American Higher Education, (New Brunswick: Princeton University Press, 1965), 18-22 details the efforts to establish the Hollis Chair, and the appointment of Greenwood.

and Zabedial Boylston in the inoculation controversy, furnished Mather with the hypothesis that smallpox was caused by germs, and most importantly persuaded Thomas Hollis, a London merchant, to contribute funds to Harvard for a divinity chair, the Hollis Professorship of Divinity. That in turn opened the door for Greenwood to ask for the endowment of a chair in mathematics.[62]

One final individual deserves some special attention. Dr. William Douglass was never a full member of the little community of men with scientific interests. He eventually won their respect for his abilities, but his irreverence toward religion and clergymen struck a discordant note among his more orthodox Boston neighbors. Scottish born and educated, he also studied at Paris. He was the only physician in the area with a medical degree. He led the fight against inoculation and carried on a ruthless campaign against Mather and Boylston. His opposition was based on several points. As the only university trained physician, he felt that his judgement should be deferred to in medical matters. He contended that Cotton Mather was meddling in areas outside his domain, and he sincerely believed that inoculation was dangerous not only to those

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[62]Stearns Science in the British Colonies provides a capsule biography, 442-446; see Curti & Nash, Philanthropy, 13-18, for details on how the endowment was procured and how Harvard violated Hollis' conditions.

inoculated, but that it put the whole community at risk by further spreading the disease.

Despite the articles which Mather read regarding inoculation, and the tales of its use in Africa, Douglass firmly believed that the procedure was not adequately tested, and that unconfirmed reports, even if they had been printed by the Royal Society, were insufficient information to justify such a dangerous procedure. He convinced almost every physician in the Boston area to oppose inoculation. He wrote pamphlets against it, and he submitted numerous articles attacking the procedure to the *New-England Courant*.

Douglass was very well read and had wide knowledge of natural history. He was a skilled botanist and made several contributions to the field. His two most important contributions were the founding of the Boston Medical Society, and the inter-colonial correspondence he undertook, most notably with his fellow Scotsman, Cadwallader Colden of New York.[63]

This growing community of New Englanders with scientific interests was nurtured by the traditional Puritan emphasis on the use of reason. From John Cotton, who in 1644 preached that to study the works of God was to gain

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[63]Adapted from Stearns, Science in the British Colonies, 477-484; for a more complete version of the inoculation controversy and Cotton Mather's role in it see Silverman, The Life of Cotton Mather, 338-363.

greater knowledge of Him, to Cotton Mather and beyond, thinkers in the Puritan tradition applied "right reason" to the understanding of creation. But it would be a mistake to make that tradition identical with the Enlightenment. For some of the New Englanders, like the Mathers, science was valuable chiefly as a support for their religious beliefs. Others were genuinely curious about the natural world, and a few, like Colman, Dudley, Douglass, Robie, and John Wise were perhaps closer to the thought of the Enlightenment than to the thought of the past. One of the most difficult problems in understanding this period of history is determining when the Enlightenment begins. The Puritan emphasis upon rationalism is not clearly different from the thought of the early Enlightenment. While it would be a mistake to claim they were identical, the difference seem to be more a matter of degree than of substance.

That there were dangers in the new philosophy did not occur to most Puritans until it was too late to change course. That acceptance of the Newtonian system posed severe problems for both religion and philosophy was not immediately understood. No longer was God the pervading essence of all things, the ulitmate object of all knowledge, but rather He was either an incompetent tinkerer continually adjusting His creation, or a remote originator, who, after setting His mechanical contrivance in motion, retreated to His heavenly throne.

> Contrast this Newtonian teleogy with that of the scholastic system. For the latter, God was the final cause of all things just as truly and more significantly than their original former. Ends in nature did not head up in the astronomical harmony; that harmony was itself a means to further ends, such as knowledge, enjoyment, and the use on the part of living beings of a higher order, who in turn were made for the still nobler end which dompleted the divine circuit, to know God and enjoy Him forever. God had no purpose; He was the ultimate object of purpose. In the Newtonian world, following Galileo's earlier suggestion, all this further teleology is unceremoniously dropped. The cosmic order of masses in motion according to law, is itself the final good. Man exists to know and applaud it; God exists to tend and preserve it.[64]

Acceptance of Newton's physics was in large part due to the conditions under which its apologists offered it. Presented as an aid to both piety and as benefitting man in his daily pursuits, it found ready acceptance among Puritans in New England.

> While it made apparent the true pattern of God's universe it would also devise instruments - thrice blessed - for improving agriculture, manufacture, and navigation, which would improve the lot (and increase the wealth) of those who labored faithfully in their callings. Thus it promised to do away, once and for all, with that opposition between acquisitiveness and piety which theology had striven in vain to reconcile.[65]

Newtonianism was not the only issue which faced the Puritans of New England. Religious disputes had caused deep division within the colony since the time of the Half

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[64]Edwin A. Burtt, The Metaphysical Foundations of Modern Physical Science, (London: Routledge and Kegan Paul, 1932), 293-294.

[65]Miller, The New England Mind, Vol. II, 441.

Way Covenant. The liberalism of Colman and Dudley, the latitudinarianism of the Brattles and Leverett, John Wise and his ideas of congregational independence, and the presbyterianism of Solomon Stoddard all occupied the attention of educated New Englanders. Additional pressures attended the loss of the charter and the institution of royal government which was made even worse by the establishment of an Anglican chapel in Boston. Fear of an Anglican establishment in their midst occupied their thoughts for a considerable length of time. Old divisions over the charter, the covenants, and the witchcraft delusions were acerbated anew with the smallpox epidemic of 1720-1721. Many of the divisions were never healed. That contributed to New England's surrender of intellectual leadership to Philadelphia.

So did other developments which came at the same time. Printing grew significantly in the first decades of the eighteenth century. Not only in New England, as Perry Miller has shown, but in the other colonies, especially in Philadelphia, there was an increase in printed material of all kinds. Communication among and between colonies increased as roads became better, the number of towns increased, and as Philadelphia in particular became a major center of business and culture. The founding of William and Mary in 1693 and Yale in 1701 further broadened the base of higher learning. Men who visited England, or who

emigrated from Europe to America, brought with them the new ideas and spirit of the enlightenment.

Acceptance of science had some consequences beyond those its early supporters imagined. It lessened the dependence on the supernatural for explanations, tended to increase belief in the ability of reason to solve human problems, and it promoted secularism, all of which are part of the enlightened ideas of the eighteenth century.

Despite the fact that intellectual leadership moved to the bustling commercial center of Philadelphia, New England did not lose its interest in science. The gift of Jeremiah Dummer to Yale of over 800 books in 1715 "included practically all of the important books on medicine and philosophy, and representative works on science and in history and literature."[66] The collection had a most significant effect upon Yale for two reasons. First, most of the works in the library until that time were badly outdated. The acquisition of works by Boyle, Newton, Locke, and Bacon, among others made the Yale library the most up to date library in the colonies, and enabled the rector and tutors to introduce their students to some of the most modern scientific ideas.

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[66]Brooks Mather Kelley, Yale: A History, (New Haven, Yale University Press, 1974), 17.

The second effect of this gift was that it brought the Enlightenment to Yale quite suddenly and dramatically. It was through these books that Rector Cutler, Samuel Johnson, and others received their exposure to the ideas which caused them to challenge the validity of Puritan ordination. Johnson, Cutler, and two others, ultimately went to England for ordination as Anglicans.

> Apparently the new rational tendencies of the age made Anglicanism appealing - the concept of man's perfectibility without the necessity of a conversion experience harmonized readily with Enlightened thought.[67]

Johnson returned to America, served as the Anglican minister at Stratford, Connecticut, and later became the first president of King's College (Columbia). "Cutler was appointed minister of the newly formed Christ Church in Boston, which became during his incumbency the militant center of New England Anglicanism."[68]

Included in the Dummer gift was a copy of Newton's *Principia*. This was one of the earliest copies of Newton's great work to reach the colonies. Yale, however, did not have the earliest known copy. That distinction probably belongs to James Logan of Philadelphia who had a copy as early as 1708.

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[67] Daniels, Science, 87.

[68] Cremin, American Education, 295.

IV. SCIENCE AND THE QUAKERS

Logan was a most remarkable man, a humanist and a scientist, whose knowledge and understanding was as broad as it was deep. A Quaker, who came to Pennsylvania as the secretary to William Penn in the last year of the seventeenth century, he made a fortune in the fur trade and was one of the wealthiest and most powerful men in Philadelphia. Logan was a powerful figure in Pennsylvania politics, serving in many important positions throughout his public career.

Logan's primary interest was mathematics along with astronomy and physics, but no field escaped his interest. "Despite his lifelong devotion to the mathematical sciences, Logan achieved most recognition in his own time for his work in botany."[69] His library was the finest in the colonies. While several were larger, none could match its quality. The scientific and mathematical works were the best editions of both ancient and modern writers from the Greeks and Arabs up to the modern age.[70]

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[69]Frederick B. Tolles, *Philadelphia's First Scientist: James Logan*, Early American Science, Brooke Hindle, Ed., (New York, Science History Publications, 1976), 94.

[70]Tolles, James Logan, 88, provides a marvelous description of the contents of the library.

The content of any library is unimportant if that library is not put to use. Logan not only studied his books, but he lent them freely. Upon his death he left his library to the city of Philadelphia for the use of everyone who shared his interests. It was from this library that John Bartram learned of Botany, and it was from those shelves that Thomas Godfrey borrowed a copy of the *Principia*. As Frederick Tolles indicates

> The existence of this great library - and Logan's generosity in giving scientifically-minded young Philadelphians the run of it - was unquestionably an important precondition of the Quaker City's emergence as the major center of scientific activity in the American colonies.[71]

Logan was not just content to introduce his young charges to books. In the case of Bartram he also introduced him to Peter Collinson, the English Quaker, who did so much in support of Botany in the Americas. He also introduced him to Linnaeus as a young man of whom much could be expected.

Logan also befriended Thomas Godfrey and they shared an interest in mathematics and astronomy which spanned many years. It was Logan who championed Godfrey's claim to the invention of the reflecting quadrant. His support of Godfrey quite possibly cost him a much deserved place in the Royal Society.

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[71] Tolles, James Logan, 88.

Both James Logan and the prominence of Philadelphia in the growth of American science must be understood within the context of Quaker thought. The Quakers, who were an offshoot of Puritanism, resembled the Puritans in several ways. In one very important area they did, however, differ from their Puritan brethern. For Quakers the source of religious truth was not external; it was not scripture, and not ministerial authority, but the Spirit of God manifest in the soul of every man. Each person followed an "inner light" which was the certain source of religious truth. Lacking ministers, Quakers were forced to discover religious truth through personal experience of the world around them.

They shared with Puritans a belief that reason was not sufficient for saving grace. Reason "was a sort of secondary light subordinate to the divine light and incapable by itself of leading to a saving knowledge of God."[72] Quakers assigned to reason the role of interpreting the natural world; there was little room within their thought for superstition or blind allegiance to authority in whatever form. Tolles indicates that while William Penn was usually quite circumspect in distinguishing between the

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[72] Frederick B. Tolles, Meeting House and Counting House, (Chapel Hill: University of North Carolina Press, 1948), 210.

Inner Light and right reason, there were points at which he assigned a greater role to reason, providing a "religious ethos as the most potent sanction for the furtherance of natural science". Tolles also describes how Penn in *Some Fruits of Solitude* advanced an argument which strongly resembled Paley's classic construct.[73]

There were two principle currents of Quaker thought. One, more mystical, emphasized a personal religious ethic which allowed no compromise with the world. The second was rational and empirical in nature. Those Quakers who followed this rule were very much a part of the world in which they lived. They believed it was "equally imperative to work out their principles of life in the complex affairs of the community and the state".[74] Quaker thought did, however, allow for a degree of flexibility in expression. Within the Society of Friends there was room for such divergent expressions of belief as the mysticism of John Woolman, the humanitarianism of the Indian missionaries, and the worldly striving of Philadelphia merchants.

In this body of thought the ethic which underpins the whole fabric of American science is to be discovered. There

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[73]Tolles, Meeting House, 211; Tolles' reference is to William Paley who argued that just as the complexity of a watch implies a watchmaker the complexity and intricacy of the universe implies the existence of a cosmic designer.

[74]Tolles, Meeting House, VII.

was no room in Quaker moral or social ethics for theory just for the sake of theory. Such enterprises were considered as idle speculation which was as useless and injurious to the life of the spirit as other vanities, fripperies, and games.

> Practical, methodical activity in the world was considered an evidence that one was indeed living "in the Light"; the expenditure of physical energy and the handling of material objects was identified with industry, whereas abstract speculation and contemplation, when not directed towards purely religious ends, was equated with idleness.[75]

For Quakers, like Puritans, "experimentation was 'the scientific expression of the practical, active, and methodical'".[76]

Humanitarianism was always a key element of the Quaker ethic. Enjoined always to 'do Good', Quakers found in science a means of doing that duty. By turning the results of the new science to useful purposes which benefitted humanity they were helping to eliminate human want and suffering, an enterprise which was by turns both exceedingly practical and eminently useful. The Quaker interest in medicine flowed out of this humanitarian impulse; the first colonial general hospital was established in Philadelphia in 1750.

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[75] Tolles, Meeting House, 206.

[76] Tolles, Meeting House, 206.

Some of the elements of Quaker thought have marked similarities to the thought of the early Enlightenment. The emphasis on practical knowledge in the Baconian sense, the role of reason in their thought, and humanitarian impulses all have their counterparts in Enlightenment thought. But it would be a mistake to overemphasize those elements. It would also be a mistake to emphasize the secular nature of their thought at the expense of the religious substance of that thought. "One cannot call them secular for the Quaker recognized no dividing line between the religious and the mundane."[77] In early Quaker thought that religious ethos predominated. Later, in the eighteenth century, the distinction between secular thought and religious thought became clearer, especially among the liberal Quakers and those who had been disowned.

By 1700 Quakers were a minority in Pennsylvania but their influence extended far beyond their numbers. Many non-Quakers were deeply affected by friendly ways either through personal acquaintance, marriage, or business association. Even the bitter wrangling between the Quaker party and the proprietary party did not hopelessly divide the community of men who shared scientific interests. The men who formed the American Philosophical Society were

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[77] Tolles, Meeting House, viii.

strongly influenced by Quaker beliefs and many of them were Quakers, liberal Quakers, former Quakers, or near Quakers.[78] The existence of this group of like-minded men was one reason Benjamin Franklin suggested the formation of a philosophical society.

The American Philosophical Society was originally founded in 1743 in response to Franklin's plea that the work of settlement had largely been completed and it was now time to turn attention to the promotion of useful knowledge and the design of improvements to make life easier. The original society did not last, but out of its remains and through the inclusion of members of a rival group which had formed in 1766, a new society began.

When the American Philosophical Society was reestablished in 1769 its membership was a cross-section of Philadelphia's leading citizens. Unlike its more narrowly composed predecessors, this society reached across religious and party lines. That presented some problems which were addressed by the appointment of three vice-presidents who were instrumental for bridging the differences which separated the various factions.

Dr. Thomas Bond, a former Quaker and an original member of the 1743 society, was one of the vice-presidents.

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[78]Brooke Hindle, *The Quaker Background and Science in Colonial Philadelphia,* Early American Science, Ed., Brooke Hindle, (New York: Science History Publications, 1976), 176.

The others were Dr. Thomas Cadwalader, an Anglican physician, who was a former Quaker, and Joseph Galloway, who was the leader of the Quaker party though not a Quaker himself. They worked to keep the lines of communication open between the society's various factions. All three men were highly respected in the community and played an essential role in assuring the society's success.[79]

Two other developments helped to insure the new society's success. Unlike its predecessors, it had the support of the wealthy Quaker merchants of Philadelphia. Also, because of British policies, the community as a whole was more united than it had previously been. The British, throughout the decade of the 1760's attempted to reassert control over the colonies through the imposition of tighter regulation and increased taxes. This, more than any other single occurrence, had united the colonists and made them acutely aware of the divergence between American and British interests.

So it was that in Philadelphia, the most cosmopolitan of American cities, that a growing community of men, of a wide variety of religious beliefs, united to share their common interest in science. Within the meeting rooms of the American Philosophical Society Anglican, Baptist,

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[79]Hindle, Early American Science, 177.

Presbyterian, and Quaker loyalties had become less important than belief in an ordered universe, governed by mathematical laws, which could be understood by human reason.

Taking their cues from their Quaker predecessors, Philadelphia's philosopher-scientists, like other such thinkers throughout the colonies, were not interested in theory for the sake of theory. That was considered idle speculation similar to the philosophizing of the schoolmen. Useful knowledge was what interested these enlightenment scientists, ideas and proposals which could benefit society now, not at some distant point in the future. That emphasis on applied science has remained one of the chief characteristics of American science to this day.

Several factors account for that emphasis. In the colonies there was still so much to learn about the natural world, and where there was so little time, and so few people to engage in such enterprises, theoretical speculation was a luxury few could afford. Even if theoretical activity had been a priority, there were very few colonials who had the resources or leisure to devote to it. Religion also seems to have played a role in charting the direction American science would take. The general protestant aversion to idle speculation arising from their rejection of scholastic argumentation was coupled with a Calvinist stricture against frivolous activities. In Philadelphia those attributes were strongly reinforced by the city's practical, humanitarian Quaker heritage.

The influence of Quaker culture in particular was remarked upon by observers, including, Jacob Duche, an Anglican priest, who "asserted that Quaker disapproval of 'all fashionable amusements and diversions, gives them the leisure and opportunity of embarking in and prosecuting such schemes as are useful, as well as ornamental to human society'".[80] Some historians, including Hindle, have suggested that the sense of loss experienced by disowned Quakers intensified the desire to do practical and useful work as a manifestation of their religious state.

The degree to which this ethic penetrated American thought is demonstrated by the activity which the transit of Venus in 1761 caused. This event was enthusiastically anticipated by astronomers throughout the world. John Winthrop, IV, the Hollis Professor of Mathematics and Natural Philosophy at Harvard, led an expedition to Newfoundland to observe the transit. His expedition promised to "advance the interests of commerce and navigation as well as those of science." That persuaded the governor and legislature of Massachusetts to support the venture by authorizing the province sloop to carry the expedition to St. John's, Newfoundland.[81]

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[80]Hindle, Early American Science, 178.

[81]John C. Green, *Some Aspects of American Astronomy 1750-1815*, Early American Science, 185.

In 1769 another transit of Venus occurred which resulted in "an inter-colonial effort of major proportions."[82] Elaborate plans were laid in the colonies to gather observations from a variety of locations in order to make comparisons and use the resulting figures for the improvement of navigation and mapmaking. As several authorities have pointed out, such observations were largely unnecessary because the distances between towns was already well known, and until better instruments were devised the figures gathered were of no use to navigators. The important point of these endeavors, however, is that they were justified by their utility, and not simply as science for the sake of science.

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[82] Greene, Early American Science, 185.

V. SCIENCE IN A CHANGING ENVIRONMENT

Neither science nor rational religion lacked opposition. Faith in reason and in the new science could be taken too far. In a limited sense the Great Awakening was a reaction against the direction society seemed to be heading. It was not science or the Enlightenment itself which raised concerns. As Henry May has observed:

> The revivals were directed not so much against the Moderate Enlightenment, as against the whole social and emotional tendency of which it was an expression.[83]

While Deism was attacked by the revivalists, it was not of primary concern. In New England before 1750 Arminianism was a worse enemy. But the easy rationality of Locke, Clark, Tillotson, and Toland was only a small part of the problem facing the churches.

> Everywhere there were complaints of false doctrine, greed, vice, even blasphemy, but the center of the problem lay in what would now be called secularism, and was then more likely to be referred to as Vanity, Worldliness, and Pride.[84]

The Great Awakening was the greatest social and religious

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[83] Henry F. May, The Enlightenment in America, (New York: Oxford University Press, 1976), 49.

[84] May, Enlightenment in America, 48.

upheaval the colonies had ever experienced and it had some lasting consequences for both religion and science. Religion in America took on a new appearance as old lines of authority were challenged and old allegiances broke down. For the first time since the colonies began the numbers of dissenters and unchurched outnumbered those belonging to the established churches. A clear line of demarcation was drawn between those who professed heart religion and those who believed in head religion, and for the first time supporters of the moderate Enlightenment were forced to defend their position.[85] An element of anti-intellectualism was introduced by the revivalists which became a theme which has ebbed and flowed throughout our history ever since, an element which proponents of rational religion or science could never again disregard with impunity.

Indirectly the Great Awakening led to the founding of the College of New Jersey (Princeton) in 1741 and to the appointment of John Witherspoon as president of the college in 1766. Witherspoon, chosen as a compromise candidate because he was an outsider, introduced the Common Sense philosophy of John Reid to America, and set Princeton on a new course, "away from the New Divinity" in vogue when he arrived. Flower and Murphey record how far Witherspoon had moved from Edwardsian thought;

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[85]May, Enlightenment in America, 52.

> in further contrast to Edwards, and it seems his own earlier position at Edinburgh, Witherspoon taught that questions of morality and virtue could be investigated as a branch of science and that our duties would be demonstrated by rational and empirical means.[86]

They go on to state that while there appears to be a question of consistency between his ethical and theological views, he believed in "a distinction between religious and scientific-philosophic undertakings" premised on the belief "that nothing a completed science will discover would profane revelation." More pointedly, Witherspoon was convinced that the "developments of science will enhance the truth and beauty of scripture."[87]

Witherspoon contributed greatly to unity among large groups of Calvinists, was active in support of the Revolution, and securely established Princeton both financially and academically. More important was the influence he exerted on those he taught and the generations which followed as he stood before his students and "promulgated the principles which were to rule college teaching for almost a century".[88] What he taught was exactly suited to the time and the place in which he taught, for

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[86]Elizabeth Flower and Murray G. Murphey, A History of Philosophy in America: Vol. I, (New York: Capricorn-Putnam, 1977), 233-234.

[87]Flower and Murphey, Philosophy in America, Vol. I, 234.

[88]May, Enlightenment in America, 64.

> Witherspoon's teaching of the Scottish philosophical principles gained power from the fact that he coupled them with the equally simple and memorable maxims of the Whig political tradition, whose "chief writers" included Grotius, Pufendorf, Harrington, Locke, Sidney, Montesquieu, and Ferguson.[89]

Witherspoon was not alone in transferring the Scottish Enlightenment to America. The physicians who contributed so much to natural history advances in America were either Scots or were trained in Scotland. Drs. William Douglass and Cadwallader Colden were but two examples of this influence.[90] The influence of the English dissenting academies, was as we have seen an important source of scientific knowledge for the colonies. Equally important was the impact of the Scottish universities on the growth of science in America. Like the dissenting academies the Scottish universities placed more emphasis on science, and "were more favorable to the use of English and the modern languages. They were more concerned about the relationship of learning to life."[91]

The Scottish influence was greatest in the middle colonies, beginning in the mid-eighteenth century. In New York, Robert Harper, Glasgow-educated, served as professor of mathematics and natural philosophy. William Churchill

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[89] May, Enlightenment in America, 64.

[90] Hindle, Pursuit of Science, 48.

[91] Hindle, Pursuit of Science, 86.

Houston, a Scot, held the same chair at Princeton beginning in 1771. The college of Philadelphia was also blessed with Scots-educated teachers. Provost William Smith was educated at Aberdeen, Vice-provost Francis Alison was trained in Glasgow; Drs. William Shippen, Jr., John Morgan, and Benjamin Rush, all educated at Edinburgh and London, and all important in the founding of the colonies first medical school, are only the most prominent names among the men educated in Scotland.

These men, and the institutions they served, had begun to form a loose network of enlightened philosopher-scientists within the colonies on the eve of the Revolution. While there was little in the way of standardized curriculum, they did communicate with each other began the institutionalization of science in the curriculum of all the colonial colleges. Dedicated to the new science and heavily influenced by Enlightenment thought they were successful in spreading scientific knowledge among growing numbers of educated Americans.

This network included Harvard under the tutelage of John Winthrop, IV, the most accomplished scientist among the teachers, and Yale, where President Thomas Clap, taught mathematics. Clap, a rigid ultra-Calvinist who had fought mightily against the encroachments of New Light doctrine at Yale, was also a first-rate scientist, though not as accomplished as Winthrop. He had contributed the design of

a plow suited to American soil, built an orrery for use in demonstrations at Yale, and proposed a theory of meteors.[92] The colleges in New York, Rhode Island, and New Jersey all had competent instruction in mathematics and natural philosophy. Both the College of Rhode Island (Brown) and Princeton had only recently filled their chairs. Philadelphia enjoyed the greatest advantages in both faculty and in the number of men in the community who actively supported science there.

Despite these signs of the growing spread of scientific knowledge, the colleges were not united and "never came to form a well-integrated community."[93] Generally the instruction they offered provided students with only "an acquaintance with sciences but no mastery of them."[94]

The revolution disrupted the development of science in America just as it disrupted every other phase of colonial life. Science took longer to regain its pre-war position than other institutions. The war caused a disruption of college life, and in some cases resulted in

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[92]Leonard Tucker, President Thomas Clap of Yale College: Another 'Founding Father' of American Science, Early American Science, Brooke Hindle, Ed., (New York, Science History, 1976) 97-119; Brooks Mather Kelley, Yale: A History, (New Haven: Yale University Press, 1974), provides details of the career of President Clap and the struggles between Old and New Lights for control of the college.

[93]Hindle, Pursuit of Science, 92.

[94]Hindle, Pursuit of Science, 93.

suspension of classes and the dispersal of the students to their homes. Some of the college libraries were damaged or destroyed, others were forced to hide their books until the war had passed them by. The war also caused other losses. Some "scientists" left for Britain, never to return, and some of the most prominent of the pre-war "scientists" passed away by the war's end. The revolution and the necessity of meeting the needs of war occupied the minds and talents of many of the most able. The need to establish governments and other political and diplomatic necessities occupied the minds of still others. The greatest loss was the loss of European, and especially British, support for American scientific endeavors. American science was heavily dependent upon that support and when it was removed American science had to struggle to reestablish itself.

VI. MILLENNIAL FERVOR, RELIGIOUS OPPOSITION AND SCIENCE

With the conclusion of the war and the establishment of a national government, enthusiasm for the new republic, possessing "a special and glorious American destiny", took hold.[95] Expressed in different forms by different thinkers it held out the vision of America as finally becoming that "beacon in the wilderness" that the earliest settlers had aspired to light. America, by her success and her example, was destined to lead a corrupt Europe to salvation. Republican government, protestant religion, and enlightened science were to illuminate the world.

Americans were nearly unanimous in seconding Paine's sentiment, that they had the opportunity to begin the world over again. A new nation facing a new century held for many the possibility of biblical fulfillment. Many believed that the millennium was at hand and

> Joel Barlow probably believed his own pronouncement: "The present age is an age of philosophy, and America, the empire of reason. Here neither the pageantry of courts nor the gloom of superstition have dazzled or beclouded the mind." In such an atmosphere, it was even possible to become convinced to a certainty that

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[95] Hindle, Pursuit of Science, 244.

the millennium was "actually to commence in the territories of the United States".[96]

This patriotic ardor found expression in little "actual creative science but did result in the "formation or expanding of institutions designed to encourage science".[97] Philosophical societies sprang up in several states, many of them short-lived. An emphasis was placed on obtaining books for college libraries, and museums were begun. This was an outgrowth of the natural history and philosophical cabinets which existed before the war. The most famous of these museums was Peale's Philadelphia museum.

In New England during the 1780's cultural nationalism was primarily expressed as a linkage among the Enlightenment, Protestantism, and patriotism. This was to be only a short-lived enthusiasm and by the 1790's was replaced by a greater fear of deism sparked in large part by Paine's *Age of Reason*. "Deism or infidelity became the main surrogate for every sort of clerical fear."[98] By 1795 the reaction against Enlightenment was nearly total. That is only partly explainable as a reaction to "European revolution and revolutionary spokesmen." For New Englanders,

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[96]Hindle, Pursuit of Science, 253.

[97]Hindle, Pursuit of Science, 248.

[98]May, Enlightenment in America, 184.

in particular, events "got most of their meaning ... from their relation to a long accumulation of New England doubts and fears".[99]

Perhaps nowhere was this reaction more clearly demonstrated than at Yale, and in the person of Ezra Stiles. Stiles served as president of Yale from 1777 to 1795. He was staunchly Old Light in his beliefs, but he was also the most enlightened of New England Calvinists and one of the most learned men of the period. He had almost single-handedly kept Yale in operation during the troubled years of the war. A member of the American Philosophical Society and a regular correspondent of Jefferson, he had extremely wide-ranging interests in natural history and natural philosophy as well as in languages and literature. Long an advocate of learned societies, he was instrumental in founding the Connecticut Society of Arts and Sciences. Under his leadership Yale was more open to new ideas and students enjoyed greater freedom of inquiry and expression than at any time in the past. Upon his death in 1795 he was succeeded by Timothy Dwight. Dwight, a long time enemy of Stiles, accused his predecessor of turning Yale into a hotbed of deism and infidelity. That was mostly an expression of Dwight's own self-doubts and fears for New

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[99] May, Enlightenment in America, 196.

England, which were typical of the region's leaders then, and did not at all reflect the reality of Yale under the guidance of Stiles.[100]

Conservative reaction to the Enlightenment and to the radical Utopianism which the Revolutionary Enlightenment had fostered did not result in a total rejection of science. Rather, there was an attempt to limit what for many were the excesses of radicalism. Many who were socially and politically conservative "befriended natural science and many devoutly religious men continued to add to the store of scientific knowledge", but rejected beliefs which "appeared to challenge orthodox religion or the established social order."[101]

President Dwight of Yale, by his appointment of Benjamin Silliman as the first holder of the chair of science at Yale in 1803, acknowledged "the necessity of recognizing science and of making certain that it was used to confirm rather than to undermine orthodox faith."[102] Silliman's

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[100]Both Hindle, The Pursuit of Science, and May, The Enlightenment in America, cite Stiles a number of times and are both helpful for placing him in the context of the period; Kelley, Yale: A History provides a clear portrait of Stiles and his influence on Yale; and Edmund S. Morgan, The Gentle Puritan: A Life of Ezra Stiles, (New Haven: Yale University Press, 1962) offers a book-length largely sympathetic and always interesting account of this remarkable man.

[101]Curti, Growth of American Thought, 207.

[102]Curti, Growth of American Thought, 207.

principle qualification for the post rested upon the fact that he was theologically safe. At the time of his appointment he was not an accomplished scientist, but he could teach the required material. What conservatives were resisting was not science, but the same elements they had always resisted. Unbridled enthusiasm and unchecked radicalism, whether for religious or social purposes, when not directed to the proper ends, was as dangerous in 1800 as it had been in 1700 or in 1637.

While French revolutionary excesses were a factor in their revulsion, conservatives, especially in New England, found targets much closer to home at which they could direct their wrath. In his 1799 Fourth of July oration entitled *Sun-Beams may be extracted from Cucumbers but the process is Tedious*, David Daggett, a New Haven high Federalist lawyer, satirically attacked some of the more exaggerated claims of science. He directed his attack at Thomas Jefferson, his supporters, the American Philosophical Society, and the French. Without ever mentioning them by name, Daggett made clear that the enemies of freedom and the New England Way were Jefferson and his fellow philosophers.[103] Daggett, like many other orthodox religious thinkers, confused

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[103]John C. Burnham, ed., Science in America, (New York: Holt, Rinehart, and Winston, 1971), 37-48 reprints the oration in its entirety.

science with irreligion or anti-religious views. More importantly, they were unable to separate differences in political opinion from differences over religious belief.

Daggett's attack on the American Philosophical Society was an indication of how the temper of the times had changed in a few short years. In the early years of the final decade of the eighteenth century the Society, under the leadership of David Rittenhouse, worked hard to keep out of the political conflicts of Philadelphia and the nation. There was an "official rule of the Society in the nineties ... that it did not take any position as a body even on scientific matters."[104] The individual who did the most to maintain that "neutrality of catholicity of spirit" was the treasurer, John Vaughn. A Federalist, Vaughn was also the rare Philadelphia Unitarian, who, "although known for his snobbery and his elegant manners ... maintained good relations with Joseph Priestley" and corresponded in French with some of the *philosophes*.[105] He continued to serve as treasurer of the Society even after the turn of the century.

The neutral position adopted by the Society allowed for the scientific cooperation of men who held widely divergent

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[104] May, Enlightenment in America, 214.

[105] May, Enlightenment in America, 214.

religious opinions. Their beliefs ranged from Benjamin Rush, who switched back and forth between Episcopalianism and Presbyterianism, and who was an ardent Calvinist evangelical "permanently and deeply affected by the Great Awakening" to Thomas Jefferson who was a moderate Deist.[106] Even Samuel Stanhope Smith, the son-in-law of John Witherspoon and his successor as president of Princeton, found the Society's doors open to him. This neutrality held until the last years of the decade. Then politics made it extremely difficult to maintain neutrality in any arena.

Jefferson became the president of the Society in 1797 upon the death of Rittenhouse. At the time he was also the Vice President of the nation and the recognized leader of an opposition party. He was the "human magnet" who drew together a group of pholosophers who shared the same enlightened ideas. Together they formed the intellectual leadership of the American Philosophical Society.[107] He was also a human lightning rod and attracted much of the wrath of those opposed to the French, to any alternative political vision, and those who feared for the future of their particular religious vision of America.

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[106] May, Enlightenment in America, 208.

[107] Daniel Boorstin, The Lost World of Thomas Jefferson, (Boston: Beacon Press, 1960, [1948]), 23.

The Society became politicized not because Jefferson wished to use it as a political instrument, but because it had him at its helm. Anything or anyone he was associated with would be viewed with suspicion by his opponents. He and the other officers attempted to keep that from happening but there were defections. Even Benjamin Rush was to retreat into neutrality in an attempt to avoid conflict.

For Rush the avoidance of controversy was always difficult. Mercurial, given to rigid, doctrinaire, positions which he defended stubbornly, he had been at the center of many of the Philadelphia medical controversies during his career. Rush was a practicing physician and taught the theory and practice of medicine at the University of Pennsylvania. A firm believer in the single cause of disease, Rush advocated bleeding in all cases to relieve the ill-humors. Even during the Yellow Fever epidemic which swept Philadelphia he clung to this practice, despite the objections of other physicians. To his credit he was also one of the very few physicians who stayed in the city throughout the epidemic to tend the sick. He attributed the epidemic to effluvia and recommended that sanitary conditions be improved. He failed to identify the disease with the mosquito which carried it, but if his recommendations had been followed the standing water, in which the mosquitos bred, would have been drained.

One of Rush's colleagues at the university was Benjamin Smith Barton, the nephew of David Rittenhouse. Barton was the "most skeptical and secular-minded of the leading members of the APS."[108] He was Professor of Materia Medica and the greatest American botanist of the age. He was led to Botany and natural history as a result of his belief that God had provided native cures for native diseases. Barton also was interested in anthropology and linguistics and submitted papers to the Society on these and other subjects.

The new century was greeted with great anticipation, especially as it coincided with the election of Thomas Jefferson as President of the nation. Most of the anticipation and enthusiasm of his friends was to be disappointed. Jefferson turned out to be practical and pragmatic in his policies and enlightened science did not get the kind of support that its advocates expected.

Certainly Jefferson would have liked to see a new system of education put in place and he would have like to see projects like a national museum, a national observatory, and a national institute modeled on the French undertaken. There was no doubt in his mind that those were useful and desirable projects for a republic to undertake, in fact his political philosophy recommended such institutions to him,

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[108]May, Enlightenment in America, 216.

but he recognized that there were more important, more useful, projects toward which the scarce resources of the nation should be directed. He also was certain that as President he did not have the constitutional authority to dictate how those resources should be used.

Science would have to get along without much government support, although Jefferson did find enough of a compelling national interest to seek funding for the Lewis and Clark expedition and for a costal survey which was begun in 1807. Unfortunately for the development of science, the New England clergy had become reactionary during the crisis at the end of the eighteenth century, had forsaken the intellectual leadership which they had exercised, and some of them had withdrawn their support and the failure of nerve by the New England intellectual elite hampered the development of American science.

Despite all of these difficulties individuals still made contributions. In 1802 Nathaniel Bowditch had published *The New American Practical Navigator*, the best work to date on the subject, and he demonstrated that Americans had kept current with the latest developments in Astronomy. In 1808 Benjamin Silliman contributed to the understanding of meteors. Agriculture began to receive more attention, and Americans never forsook their interest in natural history, medicine, and practical improvements of all varieties. Unfortunately, Americans of every shade of

belief increasingly rejected European ideas. When they needed the new ideas, and the support, of European science most they turned away, and isolated themselves in their own sense of American superiority.

Despite the difficulties they faced, those Americans who still placed their faith in enlightened religion and in science were optimistic in the first decade of the new century. Science and religion were not at war with each other in the early years of the nineteenth century. John C. Greene makes an important point in stating that "deistic natural theology was simply Christian natural theology divorced from its traditional marriage to revealed theology."[109]

Their God was a craftsman, "the Supreme Maker", remote and distant, who, having set things in motion, retired to His throne. They also believed that to understand nature was to understand the mind of God.

> Nature at once everywhere and nowhere, was the Jeffersonian City of God. While St. Augustine believed that the material universe only imperfectly hinted the potentialities of man and of God, Jefferson found there the superlative testimony of his creature.[110]

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[109] John C. Greene, American Science in the Age of Jefferson, (Ames, Iowa; Iowa State University Press, 1984) 411.

[110] Boorstin, Lost World, 171.

The "great chain of being" was a reality for them and they were certain "that there had been no errata in the Book of Creation."[111]

What Jefferson's critics seem to have missed were the influences upon his thought of men whose ideas were to play a major role in nineteenth century America. Jefferson was an admirer of Lord Kames and of Dugald Stewart, disciple and biographer of John Reid. He incorporated a good deal of the thought of the Scottish Enlightenment into his own understanding, and this, much more than the radicalism or skepticism of French thinkers, accounts for his emphasis upon a benign God, a purposeful universe, and a universal moral sense. For Jefferson common sense demanded that this be the case. If there were contradictions between theology and God's universe, revealed to man through his reason, it was theology, not observable nature, which was in error.

Rational thought, whether about religion or about science, took a different path than that which had been envisioned by the radicals of the revolutionary period. Both would live on in the colleges of America, colleges which were increasingly to become dominated by Presbyterian leadership. This leadership, heavily influenced by common sense realism, shaped generations of American minds, and

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[111]Boorstin, Lost World, 36.

was never in doubt as to the utility of both science and religion. Moral philosophy was the capstone course in these institutions and provided the ethic which would guide middle class culture for the first half of the nineteenth century. New elements were at work however, which would radically change the culture of America.

In stirring the passions of their congregations in opposition to Jefferson and Radical Enlightenment, the New England clergy unwittingly set in motion the revivals that have been called the Second Great Awakening. That, along with a more equalitarian spirit in politics, led to the demise of enlightened thought in America. Democratic values and evangelical religion were to lead to a further rejection of Europe and an anti-intellectualism which would challenge the dominance of rational religion and the science it esteemed.

VII. CONCLUSION

The changing face of America forced shifts in conservative and radical thought along more democratic terms. It was earlier assumed by both sides that an aristocracy of ability and position would rule, but then nineteenth century Americans came to think that liberty and opportunity would have to be defined in broader, more participatory, terms. Old debates based on European understandings and European conditions were replaced by debates over American realities.

Throughout America's early history science and religion were linked whenever reason played an influential role in theological understanding. The root cause for such a linkage has been located in the close association between the rise of modern science and the Puritan revolutionary experience in England. Men who valued rational theological constructs did not doubt the utility of science for furthering their understanding of God. When there were conflicts over the role of science or religion the conflicts were generally about limits or about utility. Unchecked reason was as dangerous as unchecked enthusiasm. Because of their rejection of scholasticism, and because they were

following the program detailed by Francis Bacon, inquiries were generally confined to useful knowledge.

Before their inquiries had taken them too far, men discovered that this new scientific knowledge also had a social utility, an element which we saw develop in America in the early eighteenth century. Finally it was discovered that scientific knowledge had practical utility both for national and personal wealth. This third, wholly secular purpose, would come to dominate in American science, but would never become totally separated from the imperative to do God's work in the world.

All of the above factors set the stage upon which the relationship between science and religion would be acted out until the time of Darwin. The relationship has always depended upon a delicate balance. Too much enthusiasm for science and religion would be disadvantaged, and too much enthusiasm for religion and science would be discarded. The exact utility of religion never needed to be calculated; it was a given. The utility of science was never totally certain. There were always those who doubted its utility at all, while others assumed that whatever science discovered would ultimately be found useful. There has always been a certain amount of tension regarding the utility of science, and its proper role in society. The scientist is not unlike a child with a new toy which came without instructions. The dilemma, for the scientist as for the child,

has always been how to play with it, enjoy it, yet not destroy it and everything around it. Religion formerly provided one means by which those tensions were resolved.

VIII. ANNOTATED BIBLIOGRAPHY

Becker, Carl. The Heavenly City of the Eighteenth Century Philosophers. New Haven: Yale University Press, 1932.
Becker challenges the belief in a separate Age of Faith and a separate Age of Reason. His thesis is that "the "Philosophes' were nearer the Middle Ages, less emancipated from the preconceptions of medieval Christian thought, than they quite realized or we have commonly supposed." Also of great importance are his ideas relating to the Enlightenment as religion.

Bell, Whitfield J., Jr. Early American Science: Needs and Opportunities for Study. Williamsburg: Institute of Early American History and Culture, 1955.
While dated this remains a valuable work. It contains a survey of what had been done in the field until 1955, several bibliographies, and capsule biographies of fifty early American scientists.

Berman, Mildred. "Salem's Physician-Meteorologist Dr. Edward Holyoke." Essex Institute Historical Collections 122 (July, 1986): 237-245.
This article summarizes Dr. Holyoke's life and work. The author discusses his interest in meterology as a means of predicting the outbreak of illnesses, and provides an interesting account of his 'American system' for recording temperature.

Bonomi, Patricia U. and Eisenstadt, Peter R. "Church Adherence in the Eighteenth Century British American Colonies." William and Mary Quarterly 3rd Series 39 (April, 1982): 245-286.
The authors challenge the view that religious apathy was prevalent in the period immediately preceding the Great Awakening. Membership statistics for seven major denominations in all colonies are cited in this study.

Boorstin, Daniel. The Lost World of Thomas Jefferson. Boston: Beacon, 1960, (1948).
This work is valuable primarily for illuminating the enlightened philosophy of Jefferson and his circle of friends, including Joseph Priestley, Benjamin Rush, and David Rittenhouse. Boorstin also discusses the implications of those beliefs when taken to their

logical conclusions. A most helpful discussion of one major current of Eighteenth century thought.

Burnham, John C., ed. Science in America. New York: Holt, Rinehart, & Winston, 1971.
A book of readings relating to American science and the attitudes to science on the part of various people throughout our history. The Daggett oration cited may be found in this work.

Burtt, Edwin A. The Metaphysical Foundations of Modern Physical Science. Garden City: Doubleday-Anchor, 1955.
Burtt discusses the scientific achievements and the metaphysical implications of early scientific thought from Copernicus to Newton. His thesis is that in the rush to accept the monumental scientific achievement of Newton the metaphysical implications of his work were not seriously questioned or challenged, and that this has had serious consequences for both philosophy and religion.

Cremin, Lawrence A. American Education: The Colonial Experience: 1607-1783. New York: Harper, 1970.
Part I and Chapter 6 of Part II contain materials which I found to be relevant. The English cultural tradition was dominant throughout the colonial period. This cultural tradition was not transferred without modification, but because of the English emphasis on settling families education played an important role in the transmission of that culture. Education was important not only as a transmitter of culture but it acted as a cement which bound the colonies together.

Cunningham, Noble, Jr. In Pursuit of Reason: The Life of Thomas Jefferson. Baton Rouge: Louisiana UP, 1987.
The best and most recent single volume biography on Jefferson. This book proved most helpful in checking out the relationship between Jefferson and his friends and enemies. It also provided a check on several of my own ideas which were not fully developed.

Curti, Merle E. and Nash, Roderick. Philanthropy in the Shaping of American Higher Education. New Brunswick: Rutgers UP, 1965.
The authors demonstrate how early philanthropy created the models that publicly supported universities and colleges later followed. It is also important for showing how philanthropy was used to support certain values at the expense of other values, and how it was used on occasion to ensure that certain subject matter was introduced into the curriculum.

Curti, Merle E. The Growth of American Thought. New York: Harper, 1964.

The first six chapters contain the relevant material for the period I am writing about. He argues that the colonial period saw the colonists adapt their European heritage of thought and knowledge to their new environment and that in the process ideas, beliefs, and new European intellectual developments were assimilated in somewhat modified form.

--------. The Social Ideas of American Educators. Totowa: Littlefield, 1966.

Curti argues that colonial education was a reflection of old world values and that schools were instruments for the preservation of both religious faith and the existing social and economic arrangements.

Daniels, George H. Science in American Society. New York: Knopf, 1971.

This is a comprehensive survey of science and its impact on American culture. The first six chapters contain much valuable material for understanding American science in the period I am surveying. Using a mixture of original and secondary sources he offers valuable insight into the effect of the New World upon European thinking, the activity of early colonial scientists, and the importance of the Enlightenment in colonial America.

Davis, Richard Beale. Intellectual Life in the Colonial South: 1583-1763. Knoxville: University of Tennessee Press, 1978.

Volumes I and II contain helpful information regarding southern attitudes relating to education, religion, and science. He challenges the thesis that the south was an intellectual backwater. Especially important for my purposes are the sections on educational values and the various attempts to establish an educational system in the southern colonies. The sections dealing with southern science and religion in the south are also important for my purposes.

Demos, John P. Entertaining Satan: Witchcraft and the Culture of Early New England. New York: Oxford UP, 1982.

Valuable work for understanding the relationship between Puritan belief in witchcraft and their religion. Also helpful in understanding how they tried to understand witchcraft in rational terms.

Flower, Elizabeth and Murphey, Murray G. A History of Philosophy in America, Vol. 1. New York: Capricorn-Putnam, 1977.

Pages 232-241 contain a discussion of John Witherspoon and the Scottish Enlightenment. Discusses his impact on Princeton, which he directed away from the position of its New Light founders, and is especially important for the discussion of Witherspoon's belief that the developments of science will enhance the truth and beauty of Scripture.

Gibbs, Frederick W. Joseph Priestley: Adventurer in Science and Champion of Truth. London: T. Nelson, 1965.

Biographical study of Priestley, his life and work. Offers some valuable insights on his career as a dissenting minister and his American experiences.

Greene, John C. "American Science Comes of Age." Journal of American History. LV 1 (June, 1968): 22-41.

Covers the period immediately after the Revolution and provides details on the state of American science and the problems which confronted American practitioners of science.

--------. American Science in the Age of Jefferson. Ames: Iowa State University Press, 1984.

His thesis is that the Jeffersonian era was a formative one for American science. "This was a time in which basic institutions and deep-seated attitudes toward science and its relation to the rest of American culture took shape, institutions and attitudes that were to guide the subsequent growth of American scientific development."

--------. "Science and the Public in the Age of Jefferson." Early American Science. Ed., Brooke Hindle. New York: Science History Publications, 1976. 201-213.

Explores the public perception and acceptance, of science in the period 1790-1830.

--------. "Some Aspects of American Astronomy: 1750-1815." Early American Science. Ed., Brooke Hindle, New York: Science History Publications, 1976. 135-143.

Describes some of the main directions taken by American astronomers and shows how they reflected or modified prevailing conceptions of nature.

Gorman, Mel. "Gassendi in America." Early American Science. Ed., Brooke Hindle, New York: Science History Publications, 1976. 135-143.

Gorman discusses Gassendi's works and their place in the libraries of early Americans. Despite the fact that Gassendi was a Frenchman and a Catholic, his works were read, and became part of the libraries of a number of Puritans, including Harvard students.

Hart, Sidney and David C. Ward. "The Waning of an Enlightenment Ideal: Charles Willson Peale's Philadelphia Museum; 1790-1820." Journal of the Early Republic. 8 (Winter, 1988): 389-418.

Argues that the museum was an outgrowth of the Enlightenment but that its continued success was hampered by changing cultural and intellectual values which emphasized the specialized and specific rather than the general and universal, and that it was blocked by political ideology (Jeffersonianism).

Hawke, David Freeman. Paine. New York: Harper & Row, 1974.

This is a good biography of Paine. It was primarily helpful as background material and for information regarding his origins and how his beliefs were formed.

-------. Benjamin Rush: Revolutionary Gadfly. Indianapolis: Bobbs-Merrill, 1971.

A very interesting work which provides many details of his life, his career as physician, and his activities during the revolution. It served as a helpful check on other material.

Hindle, Brooke, Lillian B. Miller, and Edgar P. Richardson. Charles Willson Peale and His World. New York: Abrams, 1983.

A biographical study and an illustrated discussion of his work. Chapter two contains material on Peale's work in science and technology. Peale was a Renaissance man who had varied careers including those of inventor and natural historian. Hindle discusses his varied careers and provides much useful information regarding the man and the period in which he worked.

Hindle, Brooke. David Rittenhouse. Princeton: Princeton University Press, 1964.

The definitive biography of Rittenhouse, covering his life and his scientific interests. Rittenhouse was a gifted individual who rose from humble origins to become one of the most prominent Americans of the Revolutionary period. Never able to fully devote his time to scientific endeavors because of financial needs and the time he devoted to the revolutionary

cause he was nevertheless regarded by his fellow countrymen as one of the most eminent American scientists.

--------. The Pursuit of Science in Revolutionary America. Chapel Hill: University of North Carolina Press, 1956.

The settlement of America took place in an age of expanding knowledge and hope. The discovery and exploration of the world provided more information than would be immediately assimilated. It was a "world of wonder" which fueled curiosity and a thirst for knowledge and gave impetus to the study of natural history.

--------. "The Quaker Background and Science in Colonial Philadelphia." Early American Science. Ed., Brooke Hindle. New York: Science History Publications, 1976. 173-180.

Hindle explores the relationship between the Quaker interest in science and the internal structure of Quaker thought. Quakers favored an empirical, rational approach to knowledge which was in the closest harmony with the pursuit of science.

Jacob, Margaret C. The Cultural Meaning of the Scientific Revolution. New York: Knopf-Borzoi, 1988.

Jacob examines the social and cultural implications of the works of Bacon, Descartes, Boyle and Newton, and the integration of the new science into English culture. Demonstrates how industrial, technological and social needs made the ideas of these men valuable, and argues that the revolutionary times greatly influenced the thinking of early English scientists. This work gave me the first germ of an idea for my project.

Kelley, Brooks Mather. Yale: A History. Hew Haven: Yale University Press, 1974.

A well documented and comprehensive history of Yale University. Parts I and II cover the period being studied. Kelley explores both the practical and religious reasons for the founding of Yale and is experienced along the way to becoming a viable institution.

Kilgour, Frederick G. "Thomas Robie (1689-1729), Colonial Scientist and Physician." Early American Science. Ed., Brooke Hindle. New York: Science History Publications, 1976. 67-84.

He discusses Robie's interest in meteorology, astronomy and medicine, and his work with smallpox vaccination.

LeMay, J. A. Leo. "Franklin and Kinnersley." Early American Science. Ed., Brooke Hindle, New York: Science History Publications, 1976.

This article provides details of Kinnersley's work with Franklin on electricity and some details of his career.

Levin David. Cotton Mather: The Young Life of the Lord's Remembrancer, 1663-1703. Cambridge: Harvard University Press, 1978.

This is probably the best account of Cotton Mather's early life available. It was primarily helpful in placing him within the context of his times.

May, Henry F. The Enlightenment in America. New York: Oxford University Press, 1976.

Essential for an understanding of the intellectual history of the period. The enlightenment took several paths in America, and it occurred later than in Europe. Also, not all the ideas popular in Europe were present in America. The Enlightenment is portrayed with protestantism as the ever-present counterpoint.

Mendelsohn, Everett. "John Lining and his Contributions to Early American Science." Early American Science. Ed., Brooke Hindle. New York: Science History Publications, 1976. 120-134.

Mendelsohn provides a good discussion of Lining's most important work. Lining was an important early southern scientist and this article is useful for the material relating to his work and the people with whom he was associated.

Miller, Perry. The New England Mind: The Seventeenth Century, Vol. 1. Cambridge: Harvard University Press, 1954.

Indispensable work for an understanding of Puritan thought and religion and the relations between the intellectual leadership of New England.

--------. The New England Mind: From Colony to Province, Vol. 2. Cambridge: Harvard University Press, 1953.

Major difference between this work and volume one is that volume one concentrates on developing all aspects of Puritan thought and theology and this work deals more with the individuals involved and the problems which they faced. The theme of declension does present some problems.

Morgan, Edmund S. The Gentle Puritan: A Life of Ezra Stiles. New Haven: Yale University Press, 1962.
A most useful book covering the life of an extraordinary man. It provides an interesting account of the intellectual, social, and political climate of the times combined with the story of his journey towards faith, his career as a minister and as president of Yale, along with his intellectual and scientific interests.

--------. "The Halfway Covenant." Intellectual History in America. Vol. 1. Ed., Cushing Strout. New York: Harper & Row, 1968. 21-34.
Morgan challenges the traditional view that the half-way covenant was a response to declining piety.

Morison, Samuel Eliot. The Founding of Harvard College. Cambridge: Harvard University Press, 1935.
Provides good background material on colonial higher education and the problems it encountered. This book provides a very good sense of the period covered, and of the importance Puritans placed upon education.

--------. The Intellectual Life of Colonial New England. New York: New York University Press, 1956.
A helpful source for material on all aspects of intellectual life. The last chapter, which deals with early New England scientific endeavors, is most helpful.

Noll, Mark A. "The Irony of the Enlightenment for Presbyterians in the Early Republic." Journal of the Early Republic. 5 (Summer, 1985): 149-175.
Noll argues that Presbyterians rejected Jonathon Edwards and adopted the didactic enlightenment with enthusiastic theoretical support, but rejected it in practice. This resulted in a muddled Christian rationalism, frustrated christian self-understanding and the possibility of a truly neutral social policy.

Numbers, Ronald L. and Janet S. Numbers. "Science in the Old South: A Reappraisal." Journal of Southern History. 39 (May, 1982): 163-184.
The authors confirm that there was less scientific activity in the south than in the north. They find no correlation between slavery and reduced scientific activity, rather they conclude that the disparity in scientific activity was due to demographic and environmental factors rather than lack of interest. Complete with charts and graphs.

Silverman, Kenneth. The Life and Times of Cotton Mather. New York: Harper & Row, 1984.

Perhaps the best single biography of Cotton Mather. Useful for information on his scientific beliefs and especially for the information relating to science and the Salem trials.

Solberg, Winton U. "Science and Religion in Early America: Cotton Mather's 'Christian Philosopher'." Church History. 56 (March, 1987): 73-92.

Solberg states that natural theology and the argument from design were transmitted from England to America through his book. A most helpful and enlightening article.

Stearns, Raymond P. Science in the British Colonies of America. Champaign: University of Illinois Press, 1970.

The most comprehensive work on colonial science. Excellent short biographical sketches of the most prominent colonial scientists. Early colonial science was nurtured by European patrons and the colonials were minor participants in early scientific endeavors. Not until the later colonial period are there contributions of ideas to science.

Stourzh, Gerald. "Sober 'Philosophe': Benjamin Franklin." Intellectual History in America, Vol. 1. Ed., Cushing Strout, New York: Harper, 1968.

Stourzh demonstrates that Franklin was as much a product of his Puritan background as he was of the enlightenment.

Stowell, Marion Barber. Early American Almanacs: The Colonial Weekly Bible. New York: Burt Franklin, 1977.

An excellent source of information on almanacs, when and where published, contents and valuable source for information on astronomy. Stowell demonstrates the shift in emphasis from one type of almanac to the farmers almanac of the eighteenth century.

Tolles, Frederick B. "Philadelphia's First Scientist, James Logan." Early American Science. Ed., Brooke Hindle. New York: Science History Publications, 1976. 86-96.

A fine essay on the science of James Logan. This essay proved most valuable for material on Philadelphia and the rising interest in science in that community.

--------. Meeting House and Counting House. Chapel Hill; University of North Carolina Press, 1948.

An extremely helpful work on Quakers and their religious thought, emphasis on reason, and science in Philadelphia. The practical emphasis which they placed upon all endeavors is an important element in the development of science in America.

Tucker, Leonard. "President Thomas Clap of Yale College: Another 'Founding Father' of American Science." Early American Science. Ed., Brooke Hindle. New York: Science History Publications, 1976. 97-119.

Clap, who was unyielding in theological matters and almost singlehandedly destroyed Yale by his refusal to compromise, was much more open to the new scientific ideas of his times than might be imagined. He was instrumental in introducing new scientific knowledge into the Yale curriculum.

Wells, Kentwod D. "William Charles Wells and the Races of Man." Early American Science. Ed., Brooke Hindle. New York: Science History Publications, 1976. 161-171.

This article discusses Well's place in the history of science as a forerunner of Darwin.

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